Virginia City Hybrid Energy Center
Response to Data Request
Bruce Buckheit, Member, Virginia Air Pollution Control Board

Question (Page No. 11):

Facts relevant to establishing BACT limits for PM, SO_2 and Hg - Identify the lowest permit limits for comparable units (PC, SCPC, CFB, IGCC)

Response:

Pulverized Coal

In a pulverized coal (PC) fired boiler, coal is pulverized to a fine powder, mixed with air and blown into the boiler or furnace for combustion. Supercritical PC boilers (SCPC) and ultrasupercritical PC boilers are the latest advancements in PC boiler technology. Both the supercritical and ultra-supercritical boiler designs operate at temperatures above the critical point thus improving the efficiency of the unit. Supercritical PC boilers are in operation (Dominion operates one supercritical PC unit), while ultra-supercritical PC boilers are not in wide use and are not considered a mature technology at this time.

In a PC boiler, the coal/air mixture combusts instantly in the flame zone of the boiler. PC boilers can be designed with various firing configurations. The most common firing configurations include tangential-fired furnaces, and horizontal or wall-fired systems. Heat generated in the boiler is directly transferred to water pumped through tubes inside the boiler to produce high-pressure steam. High-pressure steam is expanded in a steam turbine to turn a shaft connected to a generator which generates electricity. Add-on control technologies are used to reduce air emissions. Pulverized coal-fired boiler technology is a major contributor to worldwide electrical power generation with approximately 970,000 MW of capacity in operation.

Dominion Virginia Power determined that constructing a PC unit using fuel supplied from the southwest Virginia coal region was not feasible for several reasons. In order to meet the requirements of Best Available Control Technology ("BACT") for SO2 for a new PC unit, a wet scrubber would need to be an integral part of the system, which would increase the plant water requirements beyond what is available in the area. (To minimize water use which will help protect mussels in the Clinch River, the Project will employ dry cooling.) A PC boiler generally requires lower ash (below 30%) and higher Btu coal than what is available in the region. Also, a PC boiler is designed to operate on a coal with stable characteristics and would not be able to combust the variety of fuels available in the region which have widely variable characteristics. In addition, the PC boiler would not be able to burn as high a percentage of biomass. Therefore, a PC boiler located in southwest Virginia consuming run of mine or waste coal from that region is not a feasible approach.

While a PC boiler is not feasible for the proposed Project, the lowest permit limits are presented below in Table 21-1.

Table 21-1. Emission Limits (Lbs/MMBtu) for PC and SCPC Boilers			
Facility	PM/PM10	SO2	Hg
American Municipal Power	0.0250 (total)	0.15	Note 1
Basin Electric – Dry Fork (Note 2)	0.012 (total)	0.07	0.0001 (lb/MW-hr)
Western Farmers – Hugo (Note 2)	0.025 (total)	0.065	8.0E-06
Black Hills – Wygen 3	0.012 (filterable)	0.09	Note 1
Sandy Creek	327 (lb/hr)	982 (lb/hr)	0.94 (lb/hr)
Great Plains Energy	0.0244 (total)	0.10	Note 1
Public Service – Comanche (SCPC)	0.0200 (total)	Note 1	Note 1
Newmont Nevada	0.0120 (filterable)	0.09	Note 1
VCHEC	0.012 (total)	0.12	9.01E-07 (49.46 lb/yr)
Note 1 – No BACT/MACT emission limit Note 2 – These facilities are currently not in operation. No actual emissions are available.			

Circulating Fluidized Bed

Circulating Fluidized Bed (CFB) technology emerged in the early 1980s in the United States. It is considered a "clean coal technology" as defined by the Department of Energy and State Air Pollution Control Board Regulations. The CFB technology combusts solid fuels in a limestone matrix. The purpose of the limestone is to react with the sulfur contained in the coal in order to prevent it from being emitted in the flue gas. In the furnace section of the boiler, a mixture of fuel, limestone, and ash is suspended in an upwardly flowing gas stream (the combustion air). Although the fuel particles and limestone are solids, the combination of the fuel particles, limestone and combustion air exhibits fluid-like properties. Combustion air forced in at the bottom of the furnace keeps the bed in a constantly upward-moving flow. At the top of the furnace, relatively large entrained particles are separated from the smaller ash particles and returned to the furnace until combustion is complete. Combustion takes place within the boiler at high heat transfer rates, but at low combustion temperatures ranging from 1,500ºF to 1,650ºF. These lower boiler operating temperatures reduce NOx formation, while also reducing ash fusion problems and increasing sulfur capture as compared to other technologies.

VCHEC is designed to combust the fuels available in the Virginia Coalfields Region. This includes biomass, waste coal, and run-of-mine (ROM) coal. CFB is the only combustion technology demonstrated to combust the proposed fuel. ROM coal in the

Virginia Coalfields Region has a wide range of ash (30%-65%), sulfur (1%-4%) and heat content (4,000 to 10,500 Btu/lb). CFB technology has been proven for all types of fuels including high ash coal, lignite, wood wastes, petroleum coke, etc. Moreover, CFB can handle fuels with varying ash, sulfur and heat content characteristics. Table 21-2 presents permit emission limits for CFB boiler projects.
The lowest CFB permit limits are shown in the table below.

Table 21-2. Emission Limits (Lbs/MMBtu) for CFB Boilers

Facility	PM/PM10	SO2	Hg
Great River Energy	0.0120	113.7 (lb/hr)	0.0002 (lb/MW-hr)
Deseret Power (Note 2)	0.0120	0.0550	Note 1
Western Greenbrier (Note 2)	0.015	0.140	Note 1
River Hill (Note 2)	0.030	0.20	Note 3
Greene Energy	0.012	0.156	20.05 (lb/yr)
Gascoyne Generating	0.0130	0.0380	Note 1
Reliant Seward	0.010	0.60	Note 1
Spurlock Unit 3	0.015	0.20	2.65E-06
Spurlock Unit 4 (Note 2)	0.012	0.15	2.65E-06
Warrior Run	0.015	0.19	
VCHEC	0.012	0.12	9.01E-07* (49.46 lb/yr)

Note 1 – No BACT/MACT emission limit
Note 2 – These facilities are currently not in operation. No actual emissions are available.
Note 3 – EL = (1.4x10E-6 * HHr + 21E-6*HHb)/(HHr + HHb)
Where:
EL = Total pounds mercury per megawatt-hour of electricity produced on a 12-month rolling average basis
HHr = Electricity output from the generator associated with Source ID031 during the previous 12 consecutive month period related to the use of refuse coal in gross megawatt-hours generated
HHb = Electricity output from the generator associated with Source ID031 during the previous 12 consecutive month period related to the use of bituminous coal in gross megawatt-hours generated
*Based on the updated limit based on the MACT draft permit.

Integrated Gasification Combined Cycle

The Virginia SCC recently rejected the AEP Mountaineer IGCC facility. As developed further below, IGCC has not progressed to a commercial state to be deemed reasonable or prudent in the Commonwealth of Virginia.

In an Integrated Gasification Combined Cycle (IGCC) plant, the feedstock (e.g., coal or petroleum coke) is fed into a gasifier to produce a synthesis gas (syn gas) via reaction with steam and oxygen at high temperature and pressure in a reducing (oxygen-starved) atmosphere. The primary syngas constituents are carbon monoxide (CO) and hydrogen (H2), with smaller quantities of carbon dioxide (CO2), methane (CH4), and other trace

constituents. The syngas is subsequently combusted in a stationary gas turbine to generate electrical power. The hot exhaust gas from the gas turbine is then fed to a heat recovery steam generator (HRSG) to produce steam used in a turbine generator to produce additional electrical power. The exhaust gas leaving the HRSG is then emitted to the atmosphere.

The fuel conversion block includes pollution control equipment to remove pollutants from the syngas prior to combustion in the turbine. This equipment may include a wet scrubber to remove fly ash and chlorides and an acid gas control device to remove hydrogen sulfide (H2S) and carbonyl sulfide (COS), sulfur compounds formed during gasification. Because nitrogen oxides (NOx) are only produced during combustion of the syngas in the gas turbine, control efforts typically focus on minimizing NOx production in the combustion turbine.

The IGCC technology does not yet have a sufficiently demonstrated record as a consistently dependable and viable option for power plants. Consequently, current investments in coal gasification technology for electricity generation have been minimal due to cost and risk concerns. Furthermore, IGCC performs best on high-BTU, low ash fuels with stable characteristics. IGCC does not lend itself to utilization of the wide range of fuels or highly variable fuels available in the region and envisioned for use in this project, including run-of-mine or waste coal. Wabash River and Tampa Electric Polk Power are the only electric utility generating facilities currently operating in the United States. The other facilities identified are associated with petroleum refineries or chemical manufacturing facilities. The operating facilities that are not electric utility generating facilities are not required to achieve the same reliability and availability standards as a base-load electric generating facility and therefore are not considered comparable to the proposed Project.

Polk Power and Wabash River have been operating for 10 years under the U.S. DOE's Clean Coal Technology (CCT) Program to demonstrate the feasibility of IGCC and the emission rates that can be achieved by the technology.

Provided in Table 21-3 is a summary of demonstrated emission rates of Polk Power and Wabash River based on a 2002 NETL report as compared to the proposed emission limits at VCHEC. As can be seen by the table, the proposed emission limits at VCHEC compare very favorably to the emission rates that have been demonstrated at Polk and Wabash River.

Table 21-3. Emission Limits (Lbs/MMBtu) for IGCC Boilers

Facility	PM/PM10	SO2	Hg
Polk Power	0.015 (Note 1)	0.14 (Note 2)	5.2E-06 (Note 1)
Wabash River	0.012 (Note 1)	0.12 (Note 3)	7.1E-06 (Note 1)
VCHEC	0.012	0.12	9.01E-07 (49.46 lb/yr)*

Note 1 Table 1-7 (NETL 2002b).
Note 2 Calculated from lb/MWh value using actual plant operating heat rate of 9,650 Btu/kWh (NETL 2002).
Note 3 Calculated from lb/MWh value using actual plant operating heat rate of 8,900 Btu/kWh (NETL 2002a).
*Based on the updated limit based on the MACT draft permit.

Several IGCC projects that incorporate innovative technology have recently been proposed or permitted as shown in the Table 21-4. While there are three recently permitted IGCC projects that have emission limits lower than the emission rates actually achieved in practice at Polk or Wabash River, the only one under construction is a petcoke fueled unit. It is important to note that none of these facilities have been constructed or operated, thus the limits have not actually been demonstrated.

Table 21-4. Status of Recently Proposed/Permitted IGCC Projects	
Twin River Energy Center (Maine)	Local community rejected necessary change to zoning ordinance
IN THE PERMITTING PROCESS	
Duke Energy (Indiana)	Draft Air Permit Approved by Indiana URC
Excelsior - Mesaba energy Project (Minnesota)	PUC declared it an "innovative energy project" Draft EIS in public comment
AEP - Great Bend (Ohio)	PUC approved recovery of preconstruction costs
AEP - Mountaineer (West Virginia)	Rejected by Virginia PUC as unproven technology and too expensive.
PERMITTED	
Erora - Christian County (Illinois)	On appeal at EAB by Sierra Club over CO2 emissions
Erora - Cash Creek (Kentucky)	Permit Issued Nov. 30, 2007
Lima Energy (Ohio)	Construction delays have forced Lima to ask for an extension to its air permit
NOTE - Steelhead is on IEPA's list of 2006 active permits and absent on the 2007 list. The project is technically still open; however, according to IEPA, the company has terminated activity on the project. http://www.epa.state.il.us/air/permits/electric/index.html#archives	